PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H01J 7/24, 61/52, H05K 7/20 — A1

(11) International Publication Number: WO 96/13048

(43) International Publication Date: 2 May 1996 (02.05.96)

(21) International Application Number: PCT/IB95/00800

(22) International Filing Date: 26 September 1995 (26.09.95)

(30) Priority Data:
94203039.6 19 October 1994 (19.10.94) EP
(34) Countries for which the regional or international application was filed: AT et al.

(71) Applicant: PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(71) Applicant (*for SE only*): PHILIPS NORDEN AB [SE/SE]; Kottbygatan 5, Kista, S-164 85 Stockolm (SE).

(72) Inventors: MIES, Cornelis, Johannes; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL). STOMMEN, Theodoor, Hubert; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(74) Agent: EVERS, Johannes, H., M.; Internationaal Octrooibureau B.V., P.O. Box 220, NL-5600 AE Eindhoven (NL).

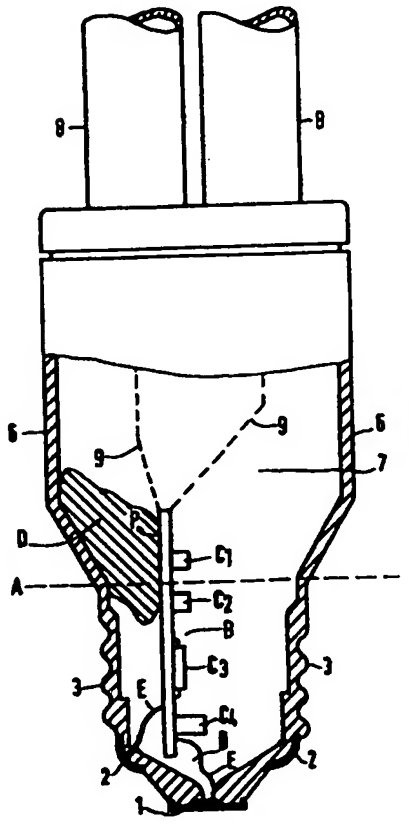
(81) Designated States: CN, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
*With international search report.*
*Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.*

(54) Title: ELECTRIC LAMP

(57) Abstract

The invention relates to an electric lamp comprising a light source provided with a vessel which is closed in a gastight manner and transmits radiation, a housing connected to the light source and provided with a lamp cap, ballast means electrically connected to the light source for operating the light source and positioned at least partly in a space surrounded by the housing, a heat-conducting body which is in contact with a portion of the ballast means and with the housing. According to the invention, the lamp is also provided with a heat-conducting plate on which at least some of the components of the remaining ballast means are provided. The heat-conducting body also forms part of a heat-conducting connection between the housing and the heat-conducting plate. An effective cooling of the ballast means is achieved thereby during lamp operation.



***FOR THE PURPOSES OF INFORMATION ONLY***

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

| | | | | | |
|---|---|---|---|---|---|
| AT | Austria | GB | United Kingdom | MR | Mauritania |
| AU | Australia | GE | Georgia | MW | Malawi |
| BB | Barbados | GN | Guinea | NE | Niger |
| BE | Belgium | GR | Greece | NL | Netherlands |
| BF | Burkina Faso | HU | Hungary | NO | Norway |
| BG | Bulgaria | IE | Ireland | NZ | New Zealand |
| BJ | Benin | IT | Italy | PL | Poland |
| BR | Brazil | JP | Japan | PT | Portugal |
| BY | Belarus | KE | Kenya | RO | Romania |
| CA | Canada | KG | Kyrgyzstan | RU | Russian Federation |
| CF | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan |
| CG | Congo | | | SE | Sweden |
| CH | Switzerland | KR | Republic of Korea | SI | Slovenia |
| CI | Côte d'Ivoire | KZ | Kazakhstan | SK | Slovakia |
| CM | Cameroon | LI | Liechtenstein | SN | Senegal |
| CN | China | LK | Sri Lanka | TD | Chad |
| CS | Czechoslovakia | LU | Luxembourg | TG | Togo |
| CZ | Czech Republic | LV | Latvia | TJ | Tajikistan |
| DE | Germany | MC | Monaco | TT | Trinidad and Tobago |
| DK | Denmark | MD | Republic of Moldova | UA | Ukraine |
| ES | Spain | MG | Madagascar | US | United States of America |
| FI | Finland | ML | Mali | UZ | Uzbekistan |
| FR | France | MN | Mongolia | VN | Viet Nam |
| GA | Gabon | | | | |

Electric lamp.

The invention relates to an electric lamp comprising

- a light source provided with a vessel which is closed in a gastight manner and transmits radiation,
- a housing connected to the light source and provided with a lamp cap,
- ballast means electrically connected to the light source for operating the light source and positioned at least partly in a space surrounded by the housing,
- a heat-conducting body which is in contact with a portion of the ballast means and with the housing.

Such an electric lamp is known from US Patent 4,739,222. The known lamp is a compact fluorescent lamp designed for replacing an incandescent lamp in general lighting applications. A major advantage of compact fluorescent lamps over incandescent lamps is their much higher luminous efficacy. A disadvantage of many compact fluorescent lamps is that the lamp dimensions are comparatively great, whereby the practical application possibilities are strongly reduced. Many manufacturers of compact fluorescent lamps have sought possibilities for reducing the dimensions of these lamps in order to counteract this disadvantage. A major problem in such a size reduction is the heat balance: in proportion as the ballast means are placed closer to the light source and closer to one another, the temperature of these ballast means during stationary lamp operation will rise. This rise in temperature usually adversely affects the life of some components forming part of the ballast means. A method of improving the heat transfer from the ballast means *via* the housing to the surroundings is to encapsulate the ballast means in the housing by means of a synthetic resin. Once the synthetic resin has set, it forms a heat-conducting connection between components forming part of the ballast means and the housing. A satisfactory cooling of the ballast means during lamp operation is realised by means of these conductive connections. At the same time, however, the weight of the lamp increases, and encapsulation is a problematic process step in the manufacture of the lamp.

In the electric lamp known from US Patent 4,739,222, cooling of a component forming part of the ballast means is realised in that a heat-conducting body is

provided which is in contact with the component and with the housing. The relevant component is effectively cooled during lamp operation by this measure. If the ballast means comprise a number of components, however, which must all be cooled during lamp operation because otherwise the temperature of these components would reach too high a value, it is necessary to connect each of these components to the housing by means of a heat-conducting body. The manufacturing process of the lamp becomes comparatively complicated in this latter case, and the lamp becomes comparatively expensive.

The invention has for its object *inter alia* to provide an electric lamp which is comparatively simple to manufacture and whose ballast means are effectively cooled during lamp operation also with comparatively small lamp dimensions.

According to the invention, this object is achieved in that the ballast means comprise a heat-conducting plate on which at least some of the components of the remaining ballast means are provided, and in that the heat-conducting body forms part of a heat-conducting connection between the housing and the heat-conducting plate.

The material from which the plate is manufactured preferably has a heat conduction coefficient of at least 20 W/mK (watt/metres*Kelvin). Mounting of those components which generate a comparatively great quantity of heat during lamp operation on the heat-conducting plate achieves that these components are all cooled *via* only one heat-conducting body and the heat-conducting plate. The heat-conducting connection between the housing and the heat-conducting plate may be formed in that the heat-conducting body is so positioned that it is in contact with one of the components placed on the heat-conducting plate and with the housing. It is more advantageous, however, to place the heat-conducting body in such a way that it is in contact both with the heat-conducting plate and with the housing, so that the heat removed through the heat-conducting connection during lamp operation does not flow entirely through one of the components but through the heat-conducting plate.

The heat-conducting body preferably comprises a heat-conducting paste. Since the paste is plastically deformable, it is very simple to position the heat-conducting body during the manufacturing process of the electric lamp in such a way that there is a good contact with the housing and with the ballast means. Also, no mechanical forces are exerted on the ballast means when a plastically deformable heat-conducting body is used, in contrast to the situation in which an elastically deformable heat-conducting body is used.

The material from which the heat-conducting plate is formed may be chosen to be, for example, a metal whose surface is coated with a synthetic-resin or enamel

layer for realising electrical insulation of the components placed on the plate. A simpler solution, however, is to form the heat-conducting plate from one material which has a high heat conduction coefficient and which is also electrically insulating. An effective cooling of the ballast means can be achieved when the heat-conducting plate comprises a material chosen from the group formed by $Al_2O_3$, AlN, and BeO. The heat conduction coefficients of these materials are 20-35, 110-170, and 150-250 W/mK.

A favourable embodiment of an electric lamp according to the invention is characterized in that the ballast means comprise a hybrid circuit provided on the heat-conducting plate. A hybrid circuit is here understood to mean a circuit partly comprising discrete components and partly comprising components provided by silk-screen printing techniques on the surface of the heat-conducting plate. The use of a hybrid circuit renders it possible to make some of the ballast means comparatively small, so that the electric lamp can be comparatively small. Thanks to the presence of the heat-conducting plate and the heat-conducting body, these comparatively small ballast means are also effectively cooled during lamp operation.

Embodiments of the invention will be explained with reference to a drawing.

In the drawing, Fig. 1 shows an embodiment of part of an electric lamp according to the invention in side elevation and partly in cross-section.

In Fig. 1, a light source 8 is provided with a (discharge) vessel which is closed in a gastight manner and transmits radiation. A housing 6 is connected to the light source and provided with a lamp cap 3, in this embodiment that part of the housing which is below the broken line A. This housing may be formed, for example, from a synthetic resin. B are ballast means electrically connected to the light source. This connection is indicated with broken lines 9 in Fig. 1. The ballast means B are placed in a space 7 which is surrounded by the housing 6. A heat-conducting plate P forms part of the ballast means B. The heat-conducting plate P is fastened in the space 7 by means not shown in Fig. 1. The ballast means further comprise components mounted on the heat-conducting plate and diagrammatically shown in Fig. 1 as C1-C4. D is a quantity of heat-conducting paste which forms a heat-conducting body which is contact with both the housing and the heat-conducting plate P. E forms current-conducting connections between the ballast means B and metal contacts 1 and 2 placed on the lamp cap, a supply voltage being present between said

contacts during lamp operation.

The operation of the electric lamp shown in Fig. 1 is as follows.

When a supply voltage is present between the metal contacts 1 and 2, the ballast means generate a current which flows through the discharge vessel forming part of the light source 8 *via* the connection 9. As a result, the light source radiates light. The components of the ballast means are heated by the electric currents which flow through the ballast means during lamp operation. The components are also heated by heat transported from the light source to the ballast means through conduction, radiation, and convection. The heat-conducting plate P, however, forms a heat-conducting interconnection between the components provided on the heat-conducting plate. The housing 6 serves as a heat sink because the heat-conducting plate is connected with heat conduction to the housing 6 through the heat-conducting body D so that the ballast means are effectively cooled through the heat conduction plate P, the heat-conducting body D, and the housing 6.

The heat-conducting plate P was made of $Al_2O_3$ in an electric lamp having a power rating of 11 W and constructed as the embodiment shown in Fig. 1. The dimensions of the plate were 1.3 cm x 2.7 cm x 0.65 mm. The heat-conducting body D was formed from approximately 0.5 g of a heat-conducting paste: Eccotherm TC-4 from Grace Electronic Material. The lamp housing was formed from polycarbonate. The temperature of a switching element forming part of the ballast means was found to be approximately 5-10° C lower during stationary lamp operation than in a corresponding lamp in which the heat-conducting body was absent. If not only the heat-conducting body was absent, but also the plate P was formed from a material with a heat conduction coefficient below 0.5 W/mK, all dimensions remaining the same, it was found that the temperature of the switching element was more than 40° C higher than in the electric lamp according to the invention during stationary lamp operation.

CLAIMS:

1. An electric lamp comprising

- a light source provided with a vessel which is closed in a gastight manner and transmits radiation,
- a housing connected to the light source and provided with a lamp cap,
- ballast means electrically connected to the light source for operating the light source and positioned at least partly in a space surrounded by the housing,
- a heat-conducting body which is in contact with a portion of the ballast means and with the housing,

characterized in that the ballast means comprise a heat-conducting plate on which at least some of the components of the remaining ballast means are provided, and in that the heat-conducting body forms part of a heat-conducting connection between the housing and the heat-conducting plate.

2. An electric lamp as claimed in Claim 1, wherein the heat conduction coefficient of the material from which the heat-conducting plate is formed is at least 20 W/mK.

3. An electric lamp as claimed in Claim 1 or 2, wherein the heat-conducting body is in contact with the heat-conducting plate and with the housing.

4. An electric lamp as claimed in any or several of the preceding Claims, wherein the heat-conducting body is formed from a heat-conducting paste.

5. An electric lamp as claimed in any one or several of the preceding Claims, wherein the heat-conducting plate comprises a material chosen from the group formed by $Al_2O_3$, AlN, and BeO.

6. An electric lamp as claimed in any one or several of the preceding Claims, wherein the ballast means comprise a hybrid circuit provided on the heat-conducting plate.

1/1

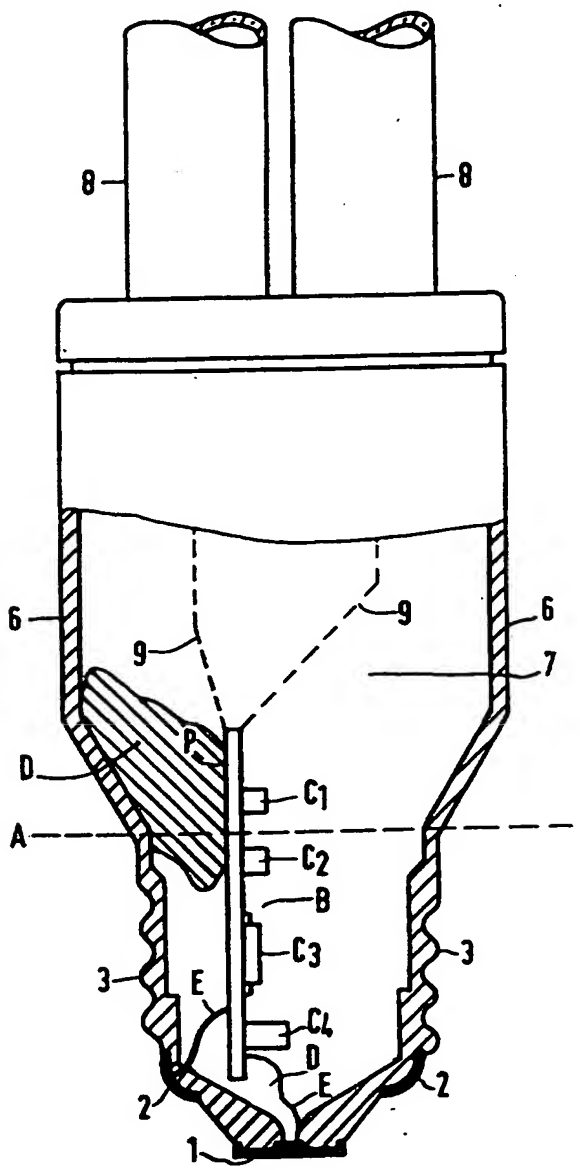



FIG. 1

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 95/00800

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01J 7/24, H01J 61/52, H05K 7/20
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H01J, H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 4389595 A (TAKETO KAMEI ET AL), 21 June 1983 (21.06.83), column 1, line 6 - line 58, figure 1, claim 1 | 1-6 |
| A | US 4739222 A (IKUYA NOMOTO ET AL), 19 April 1988 (19.04.88), abstract | 1-6 |
| A | EP 0136454 A1 (BODENSEEWERK GERÄTETECHNIK GMBH), 10 April 1985 (10.04.85), abstract | 1-6 |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 19 February 1996 | 19 -02- 1996 |
| Name and mailing address of the ISA/<br>Swedish Patent Office<br>Box 5055, S-102 42 STOCKHOLM<br>Facsimile No. +46 8 666 02 86 | Authorized officer<br>Jack Hedlund<br>Telephone No. +46 8 782 25 00 |

## INTERNATIONAL SEARCH REPORT

Information on patent family members

05/02/96

International application No.
PCT/IB 95/00800

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US-A- 4389595 | 21/06/83 | AU-B,B- 529323 | 02/06/83 |
| | | AU-A- 6237780 | 02/04/81 |
| | | CA-A- 1142153 | 01/03/83 |
| | | EP-A,A,A 0026428 | 08/04/81 |
| | | SE-T3- 0026428 | |
| | | JP-C- 1099481 | 18/06/82 |
| | | JP-B- 56046063 | 30/10/81 |
| | | JP-A- 56061537 | 27/05/81 |
| | | JP-A- 56059565 | 23/05/81 |
| | | JP-C- 1441257 | 30/05/88 |
| | | JP-A- 56060499 | 25/05/81 |
| | | JP-B- 62049639 | 20/10/87 |
| US-A- 4739222 | 19/04/88 | JP-A- 61253704 | 11/11/86 |
| | | JP-A- 62119801 | 01/06/87 |
| EP-A1- 0136454 | 10/04/85 | DE-A- 3331112 | 14/03/85 |
| | | US-A- 4583149 | 15/04/86 |